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Fostering Conceptual Change with Technology: Asian Perspectives

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Abstract: Conceptual change is one of the most important outcomes of learning. It is an intentional and constructive effort to bring about deep understanding. Researchers in this field have studied various methods and strategies to bring forth conceptual change among learners. We argue that technology can play a critical role in fostering conceptual change. Specifically, it helps learners to externalize and manipulate their internal conceptual models in order to construct or revise their conceptual understanding. When fostering conceptual change with technology, learning is meaningful, effortful, dynamic, and engaging. Through bringing together the work of scholars from various countries, we hope to forward our understanding of fostering conceptual change with technology. In this symposium, the presenters will **provide** general perspectives on the current research fostering conceptual change with technology in Asia-Pacific**, examine** social factors of learning; and **discuss** the possible approaches in various countries.

Purpose of Symposium

Conceptual change is one of the most important outcomes of learning. It is an intentional and constructive effort to bring about deep understanding. Researchers in this field have studied various methods and strategies to bring forth conceptual change among learners. Although conceptual change can be induced through strategies such as using structural alignment as analogical learning (Mason, 2004), collaborative reasoning, (Anderson et. al, 2001; Clark et. al, 2003), knowledge building (Scardamalia & Bereiter, 2006) and many other approaches, we argue that technology can play a critical role in fostering conceptual change. Specifically, it helps learners to externalize and manipulate their internal conceptual models in order to construct or revise their conceptual understanding. When fostering conceptual change with technology, learning is meaningful, effortful, dynamic, and engaging. Through bringing together the work of scholars from various countries, we hope to forward our understanding of fostering conceptual change with technology.

The overarching purpose of this symposium is to present the current state of research on fostering conceptual change with CSCL in Asia-Pacific countries in which technology is fast becoming an integrated part of learning. To accomplish our purpose, the presenters will (a) *provide* general perspectives on the current research fostering conceptual change with technology in Asia-Pacific (b) *examine* the context of learning, learners' characteristics and the role of epistemological beliefs, and (c) *discuss* the different approaches in various countries.

This symposium coincides with our forth-coming edited book *Fostering conceptual change with technology* which is scheduled to be published in early 2012. This will be the first edited book to provide a *comprehensive review* of the research in fostering conceptual change with technology as it captures and documents the related work done by prominent researchers from various Asian-Pacific countries. In addition, this book seeks to provide *varied and multiple perspectives* as it brings together researchers who seek to use technology for conceptual change and conceptual development in learning. Our authors come from 7 countries. Hence, this book will present to the readers how researchers from different Asia-Pacific countries position their research and the current research trends in their countries. In this symposium, we will be informing audience parts of the content of the book.

Our discussion begins with *Seng Chee Tan* giving our audience general perspectives on current research in Asia- Pacific. This provides the audience with a comprehensive overview of current research practices. Next, *Naomi Miyake* will address the issues of context of learning, learners' characteristic and epistemological belief which are critical components of intentional conceptual change process. She will develop these issues on a framework of mechanisms of conceptual change, to draw implications for promoting

technological support. *Jan Van Aalst* and *Chwee Beng Lee* will discuss some different approaches on the use of technology for fostering conceptual change in various countries, focusing on Hong Kong and Singapore.

Organizers, Speakers, Discussant

This symposium includes leading scholars in related but different approaches in the use of technologies for conceptual change.

Organizers/Speakers

Chwee Beng Lee, Assistant Professor of the Learning Sciences & Technologies academic group at the National Institute of Education, Nanyang Technological University. She is the co-editor of the forth coming book, *Fostering conceptual change with technologies*.

David Jonassen, Curator's Professor of Educational Psychology and Learning Technologies at the University of Missouri-Columbia who has is leading figure in learning technologies. He is the co-editor of the forth coming book, *Fostering conceptual change with technologies*.

Speakers

Naomi Miyake, Profesor of Graduate School of Education, University of Tokyo. She is co-director of Consortium for Renovating Education of the Future, to promote learner-centered, collaborative learning to Japanese public schools.

Jan Van Aalst, Associate Professor of Education at the University of Hong Kong. His research focuses on knowledge building: pedagogical designs that support it, the analysis of online discourse, and student-directed assessment of knowledge building.

Seng Chee Tan, Associate Professor and the Head of the Learning Sciences and Technologies academic group in the National Institute of Education, Nanyang Technological University, Singapore. He has been working on fostering knowledge building among K-12 students and teachers and conducting research related to technology-based pedagogies. He is leading a nationwide study evaluating the impact of the third IT Masterplan in Singapore.

Discussant

Peter Reimann, Professor of Education at the University of Sydney. Peter is the co-founder of the Research Centre for Computer-supported Learning and Cognition (CoCo) Research Centre. His research interests comprise Computer-supported collaborative learning, ICT for formative assessment, and methodological aspects of the learning sciences.

Session Format

A 90 minutes session is requested to provide ample time for speakers and audience interaction. The session plan follows:

- Chair's opening: 3 minutes
- Presenters' talk: 13 minutes
- Discussant: 15 minutes
- Panel discussion: 20 minutes

Target Audience

We anticipate that this symposium will attract interest from the following groups of people:

- Researchers and practitioners interested in understanding how to promote scientific conceptual change with technology.
- Researchers and graduate level instructors in educational psychology, learning sciences, cognitive psychology, social psychology, computer science, educational technology and teacher education.
- School educators who are keen to explore the use of technologies for deep learning/conceptual change.

Speakers' Titles and Summaries

Seng Chee Tan: Current Research in the Use of Technology for Conceptual Change in Asian Countries

Conceptual change has been extensively studied among educational researchers from a plethora of orientations, theories and disciplines, which include studies on alternative conceptions in particular domains, strategies to overcome these alternative conceptions, theories on concepts and theories on conceptual change. Despite its long history and unresolved controversies, research in conceptual change is continuing to evolve. Using CSCL technologies for conceptual change is one of the emerging themes of study among researchers in the Asian

countries. For example, She and Liao (2009, 2010) developed web-based adaptive programs that are based on multi-dimensional perspective of conceptual change. Building on the adaptive tutorial programs, Yeh and She (2010) showed that inclusion of a collaborative argumentation activity enhances the effectiveness of the program. Li (2006) described the development of MindNet, a computer-supported collaborative concept mapping system, which aims to facilitate conceptual change. Li argued that such co-construction of concept maps help participants to co-develop their evolving understanding of a topic, which leads to both individual learning and group advancement. This coheres well with the knowledge building approach (Scardamalia & Bereiter, 2006) that has also been used as an approach for conceptual change. Working with Canadian students, Chan, Burtis, and Bereiter (1997) found that knowledge building acts as a mediator for conceptual change. van Aalst and Chan continue to pursue this line of research with an emphasis on portfolio assessment. Using design experiments, knowledge building approach was implemented with graduate students in Hong Kong and Canada, 12th grade students in Hong Kong (van Aalst and Chan, 2007), and 9th grade students in Hong Kong (Lee, Chan & van Aalst, 2006). One of the key interventions was student-directed assessment, where students write a meta-note to reflect on their group processes and advancement in understanding of a topic. It was found that the use of student-directed portfolio assessment, guided by knowledge building principles, correlates significantly with students' conceptual understanding of a topic.

There remain some important works to be done in this field of study. For example, theories of conceptual change have been strongly influenced by Piaget's notion of cognitive dissonance and processes of assimilation and accomodation. The use of CSCL, on the other hand, aligns better with social constructivist and social cultural perspectives of conceptual change (e.g., Greeno & van de Sande, 2007), which are still ermerging. To provide stronger arguments for the reseach findings, researchers need to anchor their research more explicitly on these new perspectives of conceptual change. In addition, the impact of cultural and contextual factors on the use of CSCL for conceptual change in Asian countries could be a fertile ground for research. For example, what are the challenges presented by the strong emphasis on high-stake placement examinations and the competitive culture of individual achievement? In what ways do these factors influence the processes of collaborative learning and conceptual change? How do we overcome these challenges?

Naomi Miyake: Fostering Conceptual Change through Collaboration: Its Cognitive Mechanism, Socio-cultural Factors, and the Promises of Technological Support

Cognitive studies on concept formation and its subsequent change have contributed to refine distinctions between naïve, everyday construction of knowledge and the construction of more scientific concepts. In this presentation I characterize this layered structure of this process as a combination of experience-based, rather individualistic early development of theory-like, folk concepts (Clement, 2008) and more intentionally social and collaborative endeavor which comes later in school learning and scientific community efforts (Miyake, 2008).

Based on this view, I will propose a model for such cognitive mechanisms with explanations of how it is possible (Miyake, 2009; Shirouzu and Miyake, 2009 in Japanese). It has four levels according to what kind of concept is acquired how. Learning of concepts at levels one and two utilizes personal experiences. When a student "forms" a concept by experiencing one instance of some phenomenon, which is in face possible, this learning is said to have occurred on Level 1. If the same student integrates experiences of repeated encounters of the same, or similar, incident(s), s/he could integrate them into some abstracted concept, or more likely a rule of thumb. When this happens the newly formed concept is a Level 2 concept. When the same individual is introduced to others' and/or more "scientific" concepts, in media or at school, Levels 3 and 4 learning need to start. At Level 4, learners are expected and required to learn scientific, state-of-the-art concepts in adaptive ways, so that they can "use" them in suitable situations, as well as to "maintain" them so that the concept could be changed or expanded, to follow the progress of the science. There is usually a wide gap between understandings of Level 2 and 4, which often causes difficulty in school learning of scientific concepts. The model provides an intermittent level as Level 3, where the learner is expected to engage in repeated, rich collaborative learning experiences to modify the level 2 understanding in various forms, so that the learner can integrate them for abstraction, to reach the Level 4 understanding.

This model calls for collaborative, intentional learning for conceptual change tying different levels, and provides some implications about what we could/should anticipate to happen in classroom practices, with particular emphasis on the aspects of contexts of learning, learners' characteristics and epistemological beliefs of both the teacher and the learner (Miyake, in preparation). Using some concrete examples from the Consortium's current work, I will focus here on a prevalent belief in Japan, that emphasizes one-goal orientation of learning, whose existence is hard to be noticed yet this could have a profound, negative influence of changing the educational practices.

I also plan to review some instructional applications of the above approaches in current CSCL studies in Japan. I will conclude with a call for a stronger IT infrastructure to help promote community building of teachers, learners and citizens who have skill and knowledge to diversify educational situations. This call easily

extends for longer term perspective to support life long learning, to make it possible for every citizen to develop sustainable abilities to keep changing their own concepts whenever necessary.

Jan Van Aalst: Knowledge Building for Conceptual Change

I will review ways in which scholars have challenged or extended the Bereiter and Scardamalia knowledge-building model (Scardamalia, 2002; Scardamalia & Bereiter, 2006). There are four issues to consider. First, I will need to mention briefly need to discuss some important ideas in more depth, including the fit of concepts with the psychological theory of mind on which knowledge building is based, and mention epistemic aspects of conceptual change theories. Second, I will argue that an educational perspective is needed in which students are not just trying to reach a predefined end point, but the question is how far they can advance from where they presently are. Then, I want to expand what we mean by knowledge building by going beyond the focus on idea improvement to knowledge building as a (social) knowledge practice. Here I will draw from important papers on the knowledge-creation metaphor (Hakkarainen, 2009; Paavola, Lipponen, & Hakkarainen, 2004) and my own recent work (van Aalst, 2009)..

These ideas are then elaborated by drawing from studies of knowledge building. I will discuss what students learn from knowledge building and some of the factors that influence it. I examine how a specific student approached his online work, examine an example of idea improvement in an inquiry thread, and shed light on some important issues—what happens to misconceptions and how diversity of students' abilities is dealt with. Pedagogical implications for promoting conceptual change through knowledge building are then elaborated.

Chwee Beng Lee: Fostering Conceptual Change through Systems Modelling in Problem Solving

In this proposal, I argue that problem solving as an instruction-induced strategy (see Vosniadou 2007a; 2007b) approach which entails systematic instruction so that learners can understand the complex counter-intuitive scientific theory which has a different explanatory framework as compared to their naïve theories. may foster conceptual change which requires high cognitive engagement (Jonassen, 2008). Specifically, problem solving intervention can: (a) help students to become aware of the inconsistencies between their naive theories and the scientific ones and (b) create intentional learning and avoid the formation of synthetic models (Lee, 2010). Solving complex and ill-structured problems challenges problem solvers to question their own hypothesis, and externalize the problem, by going through a series of iterative sequences of testing and revising cycles (Lesh & Harel, 2003). The process of problem solving requires problem solvers to actively search for new ways to externalize their problem in order to generate a coherent problem representation. In this sense, restructuring or reorganizing the elements of problems can be regarded as a state of conceptual change. The most important step in problem solving is identifying a problem space that not only enables the restructuring of children's naïve theories but also their modes of learning. When problem solvers build problem representations, they externalize their mental model and making abstract understanding explicit so that they may reflect upon their knowledge and effectively identify their own learning or problem gap. This process is similar to the problem solving processes of scientists as they create models as systems of inquiry and use these models as means which one reasons to the new conceptual representation (Nersessian, 2008).

System dynamic modelling is a highly challenging and engaging activity (Bravo, Joolingen & de Jong, 2009) that requires learners to analyze, synthesize, and evaluate their domain-specific knowledge in order to create a model that supports their conceptual understanding of the system they are working on (Stratford, Krajcik & Soloway, 1998). Numerous studies have documented the successes of using models in problem solving activities in science learning (Stratford, Kracik, & Soloway, 1998; Lesh, & Harel, 2003). In this proposal, I will discuss how the building of problem representation using systems dynamic models may induce conceptual change and propose for using systems dynamic modelling in collaborative problem solving for fostering conceptual change.

Collaborative problem solving is a rewarding experience and can be an effective way to learn (Gijlers, Saab, Joolingen, De Jong & Van Hout-Wolters, 2009). Several studies have indicated that collaboration can enhance the quality of the learning process and its learning outcomes (e.g. Coleman 1995; Van der Linden *et al.*2000). When students work together to solve complex problems, they need to externalize their conceptual understanding, engage in dialectical argumentation, synthesize divergent ideas and resolve socio-cognitive conflicts. Such high level of commitment and engagement requires necessary scaffolding. Few researchers have developed scaffolds and learning environments that encourage the construction of collaborative repsentation (see Bravo, Van Joonlingen & De Jong, 2009; Manlove, Lazonder & De Jong, 2006).

However, there remain questions to be answered. Particularly how to effectively capture conceptual change in the process of building collaborative problem representations using systems modelling. Very little research has directly addressed the effects of systems modelling on conceptual change (Jonassen, 2008), let alone the effects of collaborative systems modelling in problem solving for conceptual change.

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